DRAFT INTERIM
HGM MODEL

FOR

KANSAS
WOODED
RIVERINE WETLANDS

Ver. 3.0

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Assessing Wetland Functions

An Approach for Assessing Wetland Functions Using Hydrogeomorphic Classification, Summary:

This document is for use by a team of individuals who adapt information to riverine wetlands in specific physiographic regions. By adapting from the generalities of the riverine class to specific regional riverine subclasses, such as high-gradient streams of the glaciated northeastern USA, the procedure can be made responsive to the specific conditions found there. For example, separation of high-gradient from low-gradient streams may be necessary to reduce the amount of variation in indicators to make the assessment more sensitive to detecting impacts.

This report outlines an approach for assessing wetland functions in the 404 Regulatory Program as well as other regulatory, planning, and management situations. The approach includes a development and application phase. In the development phase, wetlands are classified into regional subclasses based on hydrogeomorphic factors. A functional profile is developed to describe the characteristics of the regional subclass, identify the functions that are most likely to be performed, and discuss the characteristics that influence how those functions are performed. Reference wetlands are selected to represent the range of variability exhibited by the regional subclass in the selected reference domain, and assessment models are constructed and calibrated by an interdisciplinary team based on reference standards and data from reference wetlands.

Reference standards are the conditions exhibited by the undisturbed, or least disturbed, wetlands and landscapes in the reference domain. The functional indices resulting from the assessment models provide a measure of the capacity of a wetland to perform functions relative to other wetlands in the regional subclass. The application phase of the approach, or assessment procedure, includes the characterization of the wetland, assessing its functions, analyzing the results of the assessment, and applying them to a specific project. The assessment procedure can be used to compare project alternatives, determine the impacts of a proposed project, avoid and minimize impacts, determine mitigation requirements or success, as well as other applications requiring the assessment of wetland functions.

DRAFT INTERIM

The Interim Functional Assessment Procedure (IFAP) will be used to measure changes in wetland functions due to impacts and restoration. This document is being developed for riverine wetlands where the throughflow hydrology is related to out of bank flooding. The present form of this procedure is based on the Guidebook for Application of Hydrogeomorphic Assessments to riverine Wetlands(HARW), the Northern Rocky Mountain Region Alluviated Floodplain Wetlands draft HARW, the draft HGM -HARW Hopkins County, Kentucky Low Gradient Model, the Utah Low Gradient Hydrogeomorphic Model, and best professional judgment. This draft is a working document and is meant to provide the foundation for development of IFAP models particular to a specific subclass of riverine wetlands within a defined boundary (Major Land Resource Area [MLRA] or group of MLRA's).

The Hydrogeomorphic (HGM) approach to functional assessment follows three guiding principles: classification of the wetland according to geomorphic and hydrologic characteristics, identification of functions, and standardization of the assessment by using variables calibrated to reference wetlands. Classification is used to partition natural variability in wetlands, so that the assessment can be built around a smaller subset of wetlands that share common structure and functioning. Functions are commonly recognized ecosystem processes, while variables are identifiable indicators of the strength of the function.

The choice of reference standard sites is the most critical component of the HGM approach. The choice of reference sites will influence the outcome of all subsequent assessments. If you select reference sites which are too diverse in nature, from either natural variation or manmade impacts, then the resulting assessment will lack the necessary resolution to detect significant losses in functions. If your reference sites are limited to a few pristine sites, either no comparable sites will exist in the landscape, or your model will be so limited in scope as to have little practical use. This is why consensus of interdisciplinary teams is needed for the selection of standard reference sites.

Reference sites need to be the least altered sites that best represent the wetland subclass. These wetlands have the highest sustainable level of functions possible within an MLRA. If the model we have provided does not fit your situation, then you will have to rewrite the measurements or conditions that affect the variable. After you have written new measurements, you will have to test your scale against wetland sites with altered functions to ensure that your scale of measurements will detect and separate those wetland conditions you are trying to identify. Any changes to the IFAP will have to be approved through the state MOA committee. You have the option of submitting changes through the state office or inviting the MOA committee to your area for a review.

The IFAP is to be used in determining the mitigation requirements associated with the projected loss of a wetland. Before proceeding with the scoring for mitigation, the customer should have submitted a Mitigation Checklist (Appendix B). The following is an example of the steps required to assess the mitigation requirements for the loss of a wetland:

1. The wetland to be impacted is assigned a value based on comparison to the reference wetlands for each function.

2. The proposed mitigation site is reviewed for each function. The review includes the site location, management plan, project design, and professional judgment on feasibility of success at restoring each function.

You cannot rate a mitigation site to establish the mitigation until a site has been selected and the items listed above have been provided. We should provide enough information to the sponsor that they can make an intelligent decision in the selection of a proposed mitigation site. We are concerned that mitigation plans requiring personnel to manage the mitigation site, such as opening and closing valves at certain times of the year, could, in the future, create problems for the agency and the sponsor of the mitigation site. We strongly encourage that the project be designed so that the minimum required acreage is set without these manipulations. Then the producer can still manage the wetland and not have to worry about the mitigation requirements.

Mitigation will be assessed as noted on the attached work sheet , appendix D. A “time delay “ factor (Appendix G), penalty will be added to sites where mature wooded wetlands are proposed to be converted. This will provide a means for compensating for the re-establishment of a wooded stand on the mitigated site.

Riverine Wetlands Defined

This document provides the basis for applying the hydrogeomorphic (HGM) approach of wetland functional assessment to riverine wetlands. "Riverine" refers to a class of wetland that has a floodplain or riparian geomorphic setting. The other classes or geomorphic settings are depressional, slope, flats, and fringe. Water source and hydrodynamics are the other two core factors that operate within the geomorphic setting. The water sources for the riverine class are precipitation, surface flow, and groundwater discharge. Surface flow consists of overbank flow when channel capacity is exceed by discharge and overland flow that parallels the soil service when precipitation fails to infiltrate. The groundwater source includes discharge from saturated and unsaturated sources. The continuous nature of these three sources makes it difficult to separate classes based on water source alone. The dominant hydrodynamic factor is unidirectional horizontal flows for riverine and slope wetlands. In contrast, hydrodynamics are vertical fluctuations for depressional and flat wetlands, and bi-directional horizontal flow for fringe wetlands.

Riverine wetlands occur in floodplains and riparian corridors in association with stream and river channels. They continue upstream until the features of channel (bed) and bank disappear, and are replaced by slope wetlands, poorly drained flats, depressions, or uplands. Each of these conditions lacking channel flow may be equivalent to the variable source area of Roulet (1990) where water tables during storm events rise to initiate overland flow in rivulets that eventually lead to headwater channels of the stream.

First order streams, usually designated by solid blue lines on U.S. Geological Survey 7.5 minute topographic maps (scale 1:24,000), are normally associated with riverine wetlands. They may also continue further upstream where broken blue lines on topographic maps indicate the presence of channels. Perennial flow is not a requirement for a wetland to be classified as riverine.
The extent of riverine wetlands, frequently flooded, perpendicular to stream channels, continues to the maximum edge of the floodplain. The riverine HGM class terminates, as it does at its headwaters, where either slope wetlands or uplands begin. In the case of large floodplains in landscapes of great topographic relief and steep hydrostatic gradients, toe-slope wetlands connected with the floodplain may function hydrologically more like slope wetlands because of dominance by groundwater sources. In headwater streams where floodplains are lacking or only weakly developed, slope wetlands may lie adjacent to the stream channel. Large riverine wetlands may themselves contain sites with affinities to other classes. For example, oxbow features in floodplains may assume depressional characteristics for most of the year.

Riverine wetlands, as used in the HGM approach, differ from the riverine class used for National Wetland Inventory maps of the Fish and Wildlife Service (FWS). The FWS definition includes only

the river bed, bank to bank; most portions of floodplain wetlands are classified as palustrine in the FWS classification. The HGM approach classifies these areas as riverine. Rivers and floodplains in the HGM approach are assumed to be integral parts of the riverine wetland ecosystem.

Documentation of functions

The section on documentation is the core of information for the 14 functions performed by riverine wetlands (Table 1). Examples in the Riverine Guidebook are not specific for any physiographic region of the country, but rather are kept generic when possible to provide a common point of departure for the A-team. When these generic examples are adapted by A-teams for a particular physiographic region or subclasses of wetlands, procedures should be established for modifying the details by an experienced and knowledgeable group of practitioners according to some prescribed time schedule. Just as standards are developed and monitored by professionals in other disciplines, so should functional assessments be reviewed and updated by qualified experts.

Table 1. Functions of riverine wetland classes listed by four major categories.

Hydrologic
Dynamic Surface Water Storage
Long Term Surface Water Storage
Energy Dissipation
Biogeochemical
Nutrient Cycling
Removal of Elements and Compounds
Retention of Particulates
Organic Carbon Export
Plant Habitat
Maintain Characteristic Plant Communities
Maintain Characteristic Detrital Biomass
Animal Habitat
Maintain Spatial Structure of Habitat
Maintain Food Web
Maintain Interspersion and Connectivity
Maintain Distribution and Abundance of Invertebrates
Maintain Distribution and Abundance of Vertebrates

KANSAS
FUNCTIONAL ASSESSMENT
for
WOODED RIVERINE WETLAND MODEL

1.0 DYNAMIC SURFACE WATER STORAGE

Description of variables and function

For DYNAMIC SURFACE WATER STORAGE, the variables are frequency of overbank flow (V_{FREQ}), average depth of inundation (V_{INUND}), macrotopographic complexity (V_{MACRO}), woody vegetation roughness (V_{WROUGH}), herbaceous vegetation roughness (V_{HROUGH}), and coarse woody debris roughness (V_{CWD}). Overbank flow or upland surface flow is an absolute requirement for this function; if it does not occur, the index score is zero as depicted in the equation. If depth and roughness variables are all absent, the index score is also zero. It is assumed that both factors are equally important in the reference standard.

Index of Function = $[(V_{FREQ} + V_{WETUSE})/2 \times (V_{INUND} + V_{MACRO} + V_{WROUGH} + V_{HROUGH} + V_{CWD})/5]^{1/2}$

Definition: Capacity of a wetland to detain moving water from overbank flow for a short duration when flow is out of the channel; associated with moving water from overbank flow and/or upland surface water inputs by overland flow or tributaries.

Effects On-Site: Replenish soil moisture; import/export of materials (i.e. sediments, nutrients, contaminants); import/export of plant propagules; provide conduit for aquatic organisms to access wetland for feeding, recruitment, etc.

Effects Off-Site: Reduce downstream peak discharge; delay downstream delivery of peak discharges; Improve water quality.

2.0 LONG TERM SURFACE WATER STORAGE

Description of variables and function

Presence of water (V_{SURWAT}), depth to seasonal high water table(V_{WTD}),macrotopographic relief (V_{MACRO}), and microtopographic complexity (V_{MICRO}) are variables associated with the LONG TERM SURFACE WATER STORAGE function. There is no variable directly related to the actual length of time that water is present on the surface, but rather time of ponding inferred by vegetation and soil indicators of processes is compared with the reference standard. Longer times of ponding are not critically important to this function since the main off-site effect of overbank flow is the reduction of flood volume. In some wetland ecosystems, the length of time may be critical to some ecological processes and wetland functions. When this is the case, a time of ponding variable should be added to the model (consider using V_{DURAT}).
Variables used to model the LONG TERM SURFACE WATER STORAGE function differ between low and high energy riverine systems because macrotopographical relief and
micro topographic complexity variables are of widely different magnitudes in these systems.
When the source of water is direct precipitation or from upland sources, long-term storage is water ponded until lost by evapotranspiration and drainage.

For low energy systems: **Index of Function = $(V_{SURWAT} + V_{MACRO} + V_{MICRO})/3$**
For low energy systems with water tables: **Index = $(V_{SURWAT} + V_{WTD} + V_{MACRO} + V_{MICRO})/4$**

Definition: Capacity of a wetland to temporarily store surface water for long duration's. Source of water may be overbank flow, direct precipitation, or upland sources such as overland flow, channel flow, and subsurface flow. Storage is associated with standing water.

Effects On-Site: Replenishes of soil moisture; removes sediments, nutrients, and contaminants; detains water for chemical transformations; maintains vegetative composition; maintains habitat for feeding, spawning, recruitment, etc. for pool species; influences soil characteristics.

Effects Off-Site: Improves water quality; maintains baseflow; maintains seasonal flow distribution; lowers the annual water yield; recharges surficial groundwater.

3.0 ENERGY DISSIPATION

Description of variables and function

Reduction in flow velocity (V_{REDVEL}), frequency of overbank flow (V_{FREQ}), and site roughness (V_{MACRO} through V_{CWD}) are the variables describing the function. These variables must be scaled to reference standards appropriate to the hydrologic regime. The variables are combined to express the function index as follows:

Index of Function = $[V_{REDVEL} + V_{FREQ} + (V_{MACRO} + V_{MICRO} + V_{WROUGH} + V_{CWD})/4]/3$

It is assumed that each of the combined roughness variables, frequency of overbank flow, and reduction of flow velocity are equally important in maintaining the function in reference standards. Note that microtopographic complexity should usually not be used for high energy systems.

Definition: Allocation of the energy of water to other forms as it moves through, into, or out of the wetland as a result of roughness associated with large woody debris, vegetation structure, micro- and macrotopography, and other obstructions.

Effects On-Site: Increases deposition of suspended material; increases chemical transformations and processing due to longer residence time.

Effects Off-Site: Reduces downstream peak discharge; delays delivery of peak discharges; improves water quality; reduces erosion of shorelines and floodplains.

4.0 ELEMENTAL CYCLING

4.0 Discussion of Function and Variables

Index = [V_{CANOPY} + V_{WETUSE} + V_{BUFF} + $V_{DETRITUS}$ + V_{SED}]/5

Elemental cycling requires wetland plants and soil microorganisms for uptake and release of elements through growth, decomposition, and leaching. Plants, influenced by land-use activities within a riverine wetland and its adjacent buffer zone (V_{CANOPY} +V_{WETUSE} + V_{BUFF}), provide a strong seasonal pulse of temporary storage and release of elements (including nutrients). ($V_{DETRITUS}$ + V_{SED}), provide surface area decomposition and increased surface area for microbial activity. Seasonal uptake and release is a fundamental ecological function shared by all temperate and subtropical ecosystems containing plants.

Definition: Abiotic and biotic processes that convert elements (e.g. nutrients and metals) from one form to another. Primarily recycling processes.

Effects On-Site: Effects of cycling are elemental balances between gains through import processes and losses through, efflux to the atmosphere, long-term retention in sediments, and hydraulic export *(hydraulic export is minimal unless outlet leaves the basin, a reason to separate outlets that allow water to move elements and compounds out vs. pits which keep them on site*).

Effects Off-Site: To the extent that elements and nutrients are held (and processed) on-site, they are less available for export to downstream wetlands and to other aquatic environments.

5.0 REMOVAL OF IMPORTED ELEMENTS AND COMPOUNDS

5.0 Discussion of Function and Variables

The removal of imported nutrients, contaminants, and other elements and compounds via biotic and abiotic processes.

Index = [V_{WETUSE} + V_{BUFF} + V_{SED} + V_{SORPT} + (V_{FREQ} + V_{SURFIN})/2 + (V_{MACRO} + V_{MICRO} + $V_{DETRITUS}$+ V_{PDEN})/4]/6

Removal of elements and compounds can occur in flow-through riverine wetlands by the more-or-less permanent accumulation of these constituents in sediments, by denaturation of complex organics, and by processes that release them into the atmosphere (e.g., denitrification). In forested riverines, storage of elements via uptake by trees represents a relatively long-term accumulation (sink) of elements. Therefore, land-use both within (V_{WETUSE}) and adjacent (V_{BUFF}) along with surface runnof (V_{SURFIN}) to a riverine and the delivery of sediments (V_{SED}) are important to the removal of elements and compounds.

Macro and microtopographic roughness (V_{MACRO}, V_{MICRO}), plant density (V_{PDEN}), and detritus ($V_{DETRITUS}$) detain water flow to increase residence time for uptake and breakdown processes. Small-scale roughness also provides surfaces for attachment of microorganisms that are responsible for much of the sequestering, interconversion, and breakdown of imported materials.

Definition: Removal of elements and compounds can occur in riverine wetlands by accumulation of these constituents in sediments, denaturation of complex organics, and by processes that release them into the atmosphere (e.g., denitrification).

Effects On-site: Nutrients and contaminants in surface and ground water that come into contact with sediments and vegetation are either removed over the long term by sedimentation or are transformed into innocuous and biogeochemically inactive forms.

Effects -Off-site: Chemical constituents removed and concentrated in wetlands reduce potential for downstream export to other wetland and aquatic ecosystems. In addition, removal of pollutants in soil solution reduces contamination of groundwater.

6.0 RETENTION OF PARTICULATES

6.0 Discussion of Function and Variables

$$\text{Index} = [(V_{WETUSE} + V_{FREQ} + V_{BUFF} + V_{SED})/4 \text{ X } (V_{WROUGH} + V_{HROUGH} + V_{MICRO} + V_{DETRITUS})/4]^{1/2}$$

The variables used in the retention of particulates function are use and condition (Vwetuse) overbank flow (VFREQ), buffer source (VBUFF), roughness of wetland surfaces (VWROUGH, VHROUGH, VMICRO, or VDETRITUS), and evidence of retained sediments (VSED). In small streams where overbank flow seldom occurs because of the headwater position, a potential source of sediments would be from uplands as particulates transported in overland flow. Most headwater streams are erosional, however, and relatively undisturbed uplands do not serve as a substantial source of sediments. However, when uplands are disturbed and begin to release sediments, headwater streams may become depositional (Cooper and Gilliam 1987). This is possibly a function of an altered landscape and must be dealt with in the context of the reference domain. It is assumed that the transport group of variables and roughness factors are equally important in maintaining the function under reference standards.

Definition: Deposition and retention of inorganic and organic particulates from the water column primarily through physical processes.

Effects on-site: Sediment accumulation contributes to the nutrient capital of the ecosystem. Deposition increases surface elevation and changes topographic complexity. Organic matter may also be retained for decomposition, nutrient recycling, and detrital food web support.

Effects Off-Site: Reduces stream sediment load and entrained woody debris that would otherwise be transported downstream.

7.0 EXPORTS ORGANIC CARBON AND DETRITUS

7.0 Discussion of Function and Variables

Index = $[(V_{FREQ} + V_{BUFF} + V_{HYDCON} + V_{WETUSE} + V_{MICRO})/5 \times (V_{PDEN} + V_{ORGAN} + V_{DETRITUS})/3]^{1/2}$

If $V_{PDEN} + V_{ORGAN} + V_{DETRITUS}$ = 0, then the function is absent.

Two factors are required for the wetland to be a source of organic carbon for export: a source of organic matter and water flow for transport. Water flow has two components - water sources and surface hydraulic connections. The variables are frequency of overbank flow (V_{FREQ}), and overland flow or groundwater discharge from adjacent uplands (V_{BUFF}). Surface connections of the wetland with the stream channel (V_{HYDCON}) are an essential variable which provides a pathway for return flows to the channel so export actually occurs. Normally if overbank flow occurs, surface connections are present. The use and condition (V_{WETUSE}), the roughness of the wetland (V_{MICRO}), and density of the woody and herbaceous plants (V_{PDEN}) effect the amount of organic matter in the wetland. The last variable is the source of organic matter in the wetland ($V_{DETRITUS}$). This includes both living and dead organic matter(V_{ORGAN}). If either an organic carbon source is absent or surface hydraulic connections are lacking (i.e., the wetland is diked or otherwise isolated), then the function is lacking.

Definition: Export of dissolved and particulate organic carbon and detritus from the wetland (e.g., through leaching, flushing, displacement, and erosion).

Effects On-Site: The removal of organic matter from living biomass, detritus, and soil organic matter contributes to carbon turnover (plant storage) and food web support.

Effects Off-Site: Provides support for food webs and biogeochemical processing from the wetland.

8.0 MAINTAINS CHARACTERISTIC PLANT COMMUNITY

8.0 Discussion of Function and Variables

Index = (V_{WETUSE} + V_{SED} + V_{DENBA} + V_{CANOPY} + V_{STRATA} + V_{PRATIO})/6

The capacity to perpetuate a plant community through maintaining mechanisms for seed dispersal, providing substrate conductive to seed burial and storage (seed bank), and conditions conductive to vegetative propagation (a response to stressors of drought and disturbance by fire and herbivores). This function emphasizes the dynamics and structure of riverine wetland plant community, determined by species composition and abundance.

The ability of the plant community to maintains itself or the changes that will occur over time in the community are captured by characterizing six variables. The present wetland use (V_{WETUSE}) determines the plant species composition of the community (V_{PRATIO}) which is used as an indicator of current conditions as compared to the reference standard. (V_{STRATA}) and (V_{CANOPY}) are variables that are used to characterize the vertical structure (i.e., number of vertical layers of vegetation) in the plant community to compare to reference conditions. (V_{DENBA}) is used to assess biomass structure as density, and basal area of trees in the plant community provide one of the best combined measures of the maturity of the vegetation. The species present as seedlings, saplings, and as dominant herbs will provide insight into how the vegetation will change over time.

Definition: Vegetation is maintained by mechanisms such as seed dispersal, seed banks, and vegetative propagation which (all) respond to variations in hydrology and disturbances such as fire and herbivores. The emphasis is on the temporal dynamics and structure of the plant community as revealed by species composition and abundance.

Effects On-Site: Creates microclimatic conditions that support the life histories of plants and animals. Converts solar radiation and carbon dioxide into complex organic carbon that provides energy to drive food webs. Provides habitat for feeding, and cover for resting, refuge, escape, breeding and nesting for resident and migratory animals. Creates roughness that reduces velocity of floodwaters.

Effects Off-Site: Provides a source of vegetative propagules for adjacent ecosystems which assists in revegetation following drought or disturbance and provides for gene flow between populations. Provides habitat for animals from adjacent ecosystems and for migrating birds. (waterfowl, shorebirds, etc.)

9.0 MAINTAINS CHARACTERISTIC DETRITAL BIOMASS

9.0 Index of Function

Wetland use (V_{WETUSE}) affects the abundance of standing (V_{SNAGS}) and downed ($V_{DETRITUS}$) , the decay stages of the woody and herbaceous debris (V_{DECOMP}), and the abundance of piles of accumulated organic matter are the variables used to assess the detritus function. All variables must be scaled to existing reference standards appropriate for the physiographic region and the wetland's functional class.

Index of Function = $(V_{WETUSE} + V_{SNAGS} + V_{DETRITUS} + V_{DECOMP})/4$

The standing dead variable is assumed to be of equal importance to the average of the variables for decay stages and abundance of downed logs, and other accumulations of organic matter.

Definition: The processes of production, accumulation and dispersal of dead plant biomass of all sizes. Sources may be on-site or upslope and upgradient. Emphasis is on the amount and distribution of standing and fallen woody debris.

Effects On-Site: Provides the primary resources for supporting detrital based food chains, which support the major nutrient-related processes (cycling, export, import) within the wetland. Provides important resting, feeding, hiding, and nesting sites for animals of higher trophic levels. Provides surface roughness that decreases velocity of floodwaters. Retains, detains and provides opportunities for *in situ* processing of particulates. Primarily responsible for organic composition of soil.

Effects Off-Site: Provides sources of dissolved and particulate organic matter and nutrients for downstream ecosystems. Contributes to reduction in downstream peak discharges and delayed downstream delivery of peak discharges. Contributes to downstream water quality through particulate retention and detention.

10.0 MAINTAINS HABITAT STRUCTURE WITHIN WETLAND

10.0 Discussion of Function and Variables

Index = $[(V_{WETUSE} + V_{SED})/2 + (V_{CANOPY} + V_{STRATA})/2 + V_{BUFF} + V_{DETRITUS}]/4$

As is true for a number of the other riverine wetland functions, land-use activities (**V_{WETUSE}**) and sediment delivery (**V_{SED}**) are important in maintaining structural habitat . Measure the percent closure (**V_{CANOPY}**) and attributes of vertical strata (V_{STRATA}) along with (**$V_{.BUFF}$**) are a measure of the land use and condition of the land adjacent to the wetland.

Definition: Soil, vegetation, and other aspects of ecosystem structure within wetland that would support animal populations for resting, feeding, hiding, and reproduction.

Effects On-Site: Provides potential feeding, resting, hiding, escape, nesting and brooding sites for vertebrates and feeding surfaces for invertebrates.

Effects Off-Site: Provides habitat cover for migratory birds and for resident wildlife.

11.0 MAINTAINS FOOD WEBS

11.0 Discussion of Function and Variables

Index = ($V_{WETUSE} + V_{SED} + V_{BUFF} + V_{LANDSP} + V_{PRATIO} + V_{DETRITUS}$)/6

Food webs require both an energy source (e.g., primary production of appropriate species of plants) and habitat for consumers. Therefore, variables pertaining to land-use (W_{ETUSE} + V_{BUFF}) are heavily weighted in this function. The other indicators include the sustainability of a depression's basin (V_{SED}), landscape habitat factors (V_{LANDSP}) native to non-native plant species ratio (V_{PRATIO}) and the presence of litter and debris ($V_{DETRITUS}$). All indicators that could serve as variables, these indicators should be incorporated into regional variations of "Maintains Food Web" functional model.

Definition: Food webs require both an energy source and habitat for consumers.

Effects On-Site: Provides the material of live and dead plant and animal tissue to support both terrestrial and aquatic food webs.

Effects Off-Site: Supports food webs of organisms that use other wetlands and terrestrial habitat.

12.0 MAINTAINS HABITAT INTERSPERSION AND CONNECTIVITY AMONG WETLANDS

12.0 Discussion of function and variables

Index of Function = $[(V_{FREQ} + V_{DURAT})/2 + (V_{LANDSP} + V_{WETUSE})/2 + V_{MICRO} + V_{CONTIG}]/4$

The variables, frequency of overbank flow (V_{FREQ}), duration of overbank flow (V_{DURAT}), microtopographic complexity (V_{MICRO}), contiguous vegetation cover (V_{CONTIG}), corridors between wetland and upland, between channels, and between upstream-downstream areas (V_{LANDSP}), and the present use of the wetland (V_{WETUSE}) are used to assess the function of maintaining habitat interspersion and connectivity. Each indicator, must be scaled to a suite of reference wetlands and conditions appropriate for the physiographic region of the wetland's functional class.

Definition: The capacity of a wetland to permit aquatic organisms to enter and leave the wetland via permanent or ephemeral surface channels, overbank flow, or unconfined gravel aquifers. The capacity of the wetland to permit access of terrestrial or aerial organisms to contiguous areas of food and cover.

Effects On-Site: The assessed wetland contributes to habitat features of the wetland complex by virtue of its position in the landscape.

Effects Off-Site: Contributes to overall landscape diversity of habitat for aquatic and terrestrial organisms.

13.0 MAINTAINS CHARACTERISTIC INVERTEBRATE COMMUNITY

13.0 Discussion of function and variables

Index = (V_{SINVT} + V_{LINVT} + V_{SPROD} + V_{SURWAT} + V_{AQINVT})/5

The variables, species richness and density (or some similarity index) of invertebrates in soil (V_{SINVT}), species richness and density (or similarity measure) of invertebrates in leaf litter and coarse woody debris (V_{LINVT}), soil texture influences the diversity of species (V_{SPROD}), surface water is present long enough for a invertebrate species to complete life cycles (V_{SURWAT}), and species richness and density (or a similarity measure) of invertebrates in aquatic habitats (e.g., micro-depressions, seeps, side channels) (V_{AQINVT}), are used to assess the function of maintaining distribution and abundance of invertebrates. Each indicator, whether determined by direct or indirect measures must be scaled to a suite of reference wetlands and conditions appropriate for the physiographic region of the wetland's functional class.

Definition: Density and spatial distribution of invertebrates that exploit and contribute to food web.

Effects On-Site: Provides food to predators, aerates soil by building tunnels, and increases availability of organic matter for nutrient cycling microbes.

Effects Off-Site: Provides food for wide ranging predators. Transports seeds and propagules for germination elsewhere.

14.0 MAINTAINS CHARACTERISTIC VERTEBRATE COMMUNITY

14.0 Discussion of function and variables

Index = (F8+F9+F10+F11+F13+$V_{OBSVERTUSE}$)/6

The observation ($V_{OBSERTUSE}$) of variables, diversity and density of permanent and seasonally resident vertebrate (fish, herptiles, mammals, and migratory avifauna), are used to assess the function of maintaining distribution and abundance of invertebrates. Each indicator, whether determined via direct or indirect measures must be scaled to a suite of reference wetlands and conditions appropriate for the physiographic region of the wetland's functional class.

Definition: Density and spatial distribution of vertebrates that exploit wetland habitat.

Effects On-Site: Provides food to vertebrate predators and offspring for population maintenance and growth after declines.

Effects Off-Site: Provides offspring for dispersal to other sites; and the dispersal of seeds and plant propagules between sites.

Model Variable	Measurement or Condition	Index
V_{AQINVT}: **Aquatic invertebrates**. Definition: Distribution and abundance of invertebrates in aquatic habitats (micro-depressions, side channels, seeps)	Presence of suitable aquatic habitats (microdepressions, seeps, etc.) and evidence of shell fragments, exudate, etc., similar to reference standard.	1.0
Example: The presence of shell fragments, egg cases.	No evidence of items above, but with potential for recovery of habitat to reference standard.	0.1
	No evidence of suitable aquatic habitats and no potential for habitat recovery.	0.0

V_{AQINVT} Aquatic Invertebrates
F13 Maintains Characteristic Invertebrate Community

Model Variable	Measurement or Condition	Index
V_{BUFF}: Buffer Zone Definition: Dominant land use and condition of the buffer zone adjacent to the wetland. Example: Grazing, logging burning, tillage development, and drainage activities in the buffer zone impact the delivery of elements and compounds to the wetland.	Relatively undisturbed with evidence of surface water movement to the wetland. Minimum of 100 feet wide buffer with natural vegetation.	1.0
	Some disturbance with indications of water movement to the wetland. Buffer 50 to 99 feet wide undisturbed with natural vegetation.	0.5
	Some disturbance with indications of water movement to the wetland. Buffer with 10 to 49 feet wide with natural vegetation.	0. 25
	Disturbance (rills, gullies, bare ground, etc.) with indications of high rate of runoff with a buffer width of less than 10 feet.	0.0

V_{BUFF} Buffer Zone
F-4 Elemental Cycling
F-5 Removal of Imported Elements and Compounds
F-6 Retention of Particulates
F-7 Exports Organic Carbon and Detritus
F-10 Maintains Habitat Structure
F-11 Maintains Food Webs

Model Variable	Measurement or Condition	Index
V_{CANOPY}: Canopy Cover Definition: Canopy cover of each stratum in each plant community. Example: Measure of change in strata from reference site. Changes in strata impact quality of wetland.	The measure of canopy cover is $\geq$ 75% in each stratum present in the reference standard.	1.0
	The measure of canopy cover is $\geq$ 75% of the reference standards in one stratum of a plant community.	0.5
	The measure of canopy cover is 0-75% of reference standards in two strata of a plant community.	0.25
	The measure of canopy cover is 0-75% of reference standards in three strata of a plant community.	0.10
	Vegetation is sparse or absent.	0.0

V_{CANOPY} Canopy Cover
F-4 Elemental Cycling
F-8 Maintains Characteristic Plant Community
F-10 Maintains Habitat Structure

Model Variable	Measurement or Condition	Index
V_{CONTIG}: Contiguous vegetation cover Definition: Continuity among vegetation connections between channels, uplands, and upstream-downstream wetland areas.(within 0.5 km or 0.3 mi) Example: Wetlands 1/2 mile apart have streamside riparian vegetation connection.	Recent aerial photographs taken during leaf season show abundant vegetation and vegetated corridors connecting mosaics of habitat types similar to reference standard.	1.0
	Recent aerial photographs taken during leaf season show lower abundance vegetative connections than reference standard.	0.5
	Aerial photographs taken during leaf season lack of continuous vegetation connections with potential for recovery.	0.1
	Aerial photographs taken during leaf season lack of continuous vegetation connections with no potential for recovery.	0.0

V_{CONTIG} Contiguous Vegetation Cover
F-12 Maintains Habitat Interspersion and Connectivity

Model Variable	Measure or Condition	Index
V_{CWD}: Coarse woody debris Definition: Volume of dead, down trees and limbs larger than a pre-determined defined diameter. (>10 cm) Example: Roughness of CWD contributes to dissipation energy and slowing the movement of water.	Biomass and volume of CWD is >75% of reference standard. Presence of dead trees, snags, limbs, and debris piles.	1.0
	Biomass and volume of CWD is between 25% and 75% that of reference standard.	0.5
	Biomass and volume of CWD is between 0% and 25% that of reference standard; restoration possible.	0.1
	No CWD present; restoration not possible.	0.0

V_{CWD} Coarse Woody Debris
F-1 Dynamic Surface Water Storage
F-3 Energy Dissipation

Model Variable	Measurement or Condition	Index
V_{DECOMP}: Decomposition of wood and/or plant litter Definition: An array of decompositional stages. Example: Rotted tree log provides habitat for invertebrates and some vertebrates.	Visual estimate of woody debris and herbaceous litter in stages of decomposition between 75% to 125% of reference standard.	1.0
	Visual estimate of woody debris and herbaceous litter in stages of decomposition between 25% to 75% or > 125% of reference standard.	0.5
	Visual estimate of woody debris and herbaceous litter in stages of decomposition between 0 to 25% of reference standard.	0.1
	Woody debris and litter absent, no decomposition occurring.	0.0

V_{DECOMP} Decomposition of Wood and/or Plant Litter
F-9 Maintains Characteristic Detrital Biomass

Model Variable	Measurement or Condition	Index
V_{DENBA}: Tree density and basal area Definition: The density and basal area of trees. Example: Changes in forested plant community impact several wetland functions.	The measure of tree density and basal area is > 75% of the reference standard conditions.	1.0
	The measure of tree density and basal area is > 25% - 75% of the reference standard conditions.	0.5
	The measure of tree density and basal area is > 0-25% of the referenced standard conditions.	0. 10
	The measure of tree density and basal area is 0% of the reference standard conditions.	0.0

V_{DENBA} Tree Density and Basal Area
F-8 Maintains Characteristic Plant Community

Model Variable	Measurement or Condition	Index
$V_{DETRITUS}$: Detritus Definition: The presence of small woody debris and litter in several stages of decomposition. (O surface horizon) Example: In combination with other roughness factors (V_{MICRO}, $V_{DETRITUS}$), roughness will result in a slowing of water flow and provide increased time and surface area for processing and export of organic carbon.	Small woody debris and herbaceous litter 75% to 125% of reference standard. Small woody debris and litter 25% to 75% or > 125% of reference standard. Small woody debris and litter layer 0 to 25% of reference standard. Small woody debris and litter absent	1.0 0.5 0. 1 0.0

$V_{DETRITUS}$ Detritus

F-4 Elemental Cycling
F-5 Removal of Imported Elements and Compounds
F-6 Retention of Particulates
F-7 Exports Organic Carbon and Detritus
F-9 Maintains Characteristic Detrital Biomass
F-10 Maintains Habitat Structure
F-11 Maintains Food Webs

Model Variable	Measurement or Condition	Index
V_{DURAT}: Duration of overbank flow	* Flood duration between 75% and 125% of reference standard. Duration of connection related indicators only, and similar to reference standard.	1.0
Definition: Overbank flow duration permits organisms sufficient time to access floodplain wetlands for spawning and feeding. Example: Overbank flow allows organisms and fish access to floodplain wetland.	Flood duration between 25% and 75% or >125% of reference standard. Any indicators, i.e., aerial photos showing continuity of duration, flooding tolerance of tree species, etc., showing continuity of flooding as less than reference standard. _____ Flood duration between 0% and 25% of reference standard. Any indicators showing greatly reduced duration relative to reference standard _____ No overbank flow. Flooding is absent	0.5 _____ 0.1 _____ 0.0

* Use USGS gage data, if available, as a hydrology tool.

V_{DURAT} Duration of Overbank Flow
F-12 Maintains Habitat Interspersion and Connectivity

Model Variable	Measurement or Condition	Index
V_{FREQ}: Frequency of overbank flow Definition: Frequency or recurrence interval at which bank-full discharge is exceeded. Example: Intermittent stream over tops bank annually.	* [<2] yr. return interval; similar to reference standard. At least one of the following: aerial photos showing flooding, water marks, silt lines, alternating layers of leaves and fine sediment, drift and/or wrack lines, sediment scour, sediment deposition, directionally bent vegetation similar to reference standard.	1.0
	[>2] yr. return interval; slight departure from reference standard. As above, but somewhat greater or less than reference standard.	0.5
	>.10-25 yr. return interval; great departure from reference standard.	0.25
	>25 yr. return interval. Extreme departure from reference standard. Above indicators absent but related indicators suggest overbank flow may occur.	0.1
	No flooding from overbank flow. Indicators absent and/or there is evidence of alteration affecting variable.	0.0

* Use USGS gage data, if available, as a hydrology tool.

V_{FREQ} Frequency of Overbank Flow

F-1 Dynamic Surface Water Storage
F-3 Energy Dissipation
F-5 Removal of Imported Elements and Compounds
F-6 Retention of Particulates
F-7 Exports Organic Carbon and Detritus
F-12 Maintains Habitat Interspersion and Connectivity

Model Variable	Measure or Condition	Index
V_{HROUGH} : Herbaceous vegetation roughness Definition: Corresponds to the density of herbaceous vegetation that reduces stream flow. Example: Roughness of vegetation density that detains water, trap organic debris, and slow water movement.	Herbaceous density and/or biomass scaled as a linear function of reference standard. Visual estimate of herbaceous vegetation indicates site is similar (between 75% and 125%) to reference standard.	1.0
	. Visual estimate of herbaceous vegetation indicates site is less (25 to 75%) than reference standard.	0.5
	Herbaceous vegetation sparse or absent relative to reference standard; restoration possible.	0.1
	Herbaceous vegetation absent; restoration not possible.	0.0

V_{HROUGH} Herbaceous Vegetation Roughness
F-1 Dynamic Surface Water Storage
F-6 Retention of Particulates

Model Variable	Measure and Condition	Index
V_{HYDCON}: Surface hydraulic connections	No obstructions such as levees, dams, or diversions present, entire floodplain connected to channel or wetland subject to natural flooding regime.	1.0
Definition: The presence of surface water connections between the wetland and the stream channel.	Man-made obstructions present with connections to channel.	0.1
. Example: Conduits of overbank flow and drainage's provide inlets and outlets through wetlands.	Man-made obstructions present with no connections to channel.	0.0

V_{HYDCON} Surface Hydraulic Connections
F-7 Exports Organic Carbon and Detritus

Model Variable	Measure or Condition	Index
V_{INUND}: Average depth of inundation	* Depth is between 75% and 125% that of reference standard. Height of water stains and other indicators of water depth (ice scars, bryophyte lines, drift and/or wrack lines, etc.) between 75% and 125% of reference standard.	1.0
Definition: Average flooding depth during overbank flooding events. . Example: Water stain on tree trunks or debris drift line present	Depth is <75% or >125% of reference standard. Height of water stains and other indicators of water depth (ice scars, bryophyte lines, drift and/or wrack lines, etc.) between 50% and 75% of reference standard.	0.5
	Infrequent or minor overbank flooding relative to reference standard. Above indicators absent but related indicators suggest variable may be present. .	0.1
	Flooding does not occur. Indicators absent and/or evidence of alteration affecting the variable.	0.0

* Use USGS gage data, if available, as a hydrology tool.

V_{INUND}: Average depth of inundation
F-1 Dynamic Surface Water Storage

Model Variable	Measurement or Condition	Index
V_{LANDSP}: Landscape. Definition: Condition of landscape within riverine watershed of the wetland being assessed. Example: Conditions of landscape in vicinity of wetland determines the quality of potential dispersal area and home range for fauna that depend upon a mosaic of wetland and upland habitats.	Surrounding landscape supports $\geq$ 75% mosaic of natural plant community.	1.0
	Surrounding landscape supports 50% to 75% mosaic of the natural plant community	0.5
	Surrounding landscape supports 25% to 50% mosaic of the natural plant.	0.1
	Surrounding landscape supports less than 25% mosaic of the natural plant community.	0.0

V_{LANDSP} Landscape
F-11 Maintains Food Webs
F-12 Maintains Habitat Interspersion and Connectivity

Model Variable	Measure or Condition	Index
$V_{LINVT:}$ Litter invertebrates Definition: Distribution and abundance of invertebrates in leaf litter and in coarse woody debris	Visual assessment of galleries in logs and twigs, tunnels in wood, shells, casts, trails, holes, etc. similar to reference standard (measures may be developed that can be quantified).	1.0
Example: Insects in and under detritus material.	As above, but less much less than reference standard.	0.5
	Absence of galleries in logs and twigs, tunnels in wood, shells, casts, trails, holes, etc. but with potential for habitat recovery.	0.1
	As above, but no potential for habitat recovery.	0.0

V_{LINVT} Litter Invertebrates
F13 Maintains Characteristic Invertebrate Community

Model Variable	Measurement or Condition	Index
V_{MACRO}: Macrotopo-graphic relief Definition: Large-scale relief in the form of oxbows, meander scrolls, abandoned channels, and backswamps. Example: Old meander scroll adjacent to stream channel.	1. Contour maps indicate gross relief and/or closed contours similar to reference standard **or** 2. Topographic survey shows relief similar to reference standard. 3. Soil survey water features indicate wet areas Oxbows, meander scrolls, abandoned channels, backswamps, etc. similar in magnitude to reference standard.	1.0
	Indicators above much less developed than reference standard and area has a low surface gradient.	0.5
	Maps and/or topographic survey indicate relief very dissimilar to reference standard. All above indicators absent and area has a moderate to steep gradient	0.0

V_{MACRO} Macrotopographic Relief
F-1 Dynamic Surface Water Storage
F-2 Long Term Surface Water Storage
F-3 Energy Dissipation
F-5 Removal of Imported Elements and Compounds

Model Variable	Measure or Condition	Index
V_{MICRO}: Microtopographic complexity Definition: Small-scale topographic relief in the form of pit-mound patterns, splays, scours and shallow depressions.	Microtopographic complexity (MC) measured (surveyed) shows MC >75% of reference standard. Visual estimate indicates that microtopographic complexity (MC) is >75% of reference standard.	1.0
	Measured MC is between 25% and 75% that of reference standard. Visual assessment confirms MC is present, but somewhat less than reference standard.	0.5
Example: The roughness of a riverine wetland seen as small lows usually less than 6 inches, that aid in slowing in-stream flow and provide more micro habitat.	Measured MC between 0% and 25% that of reference standard; restoration possible. Visual assessment indicates MC is much less than reference standard; restoration possible.	0.1
	No MC at assessed site or natural substrate replaced by artificial surface. Visual assessment indicates MC is virtually absent or natural substrate replaced by artificial surface; restoration not possible.	0.0

V_{MICRO} Microtopographic Complexity
F-2 Long Term Surface Water Storage
F-3 Energy Dissipation
F-5 Removal of Imported Elements and Compounds
F-6 Retention of Particulates
F-7 Exports Organic Carbon and Detritus
F-12 Maintains Habitat Interspersion and Connectivity

Model Variable	Measurement or Condition	Index
$V_{OBSVERTUSE}$: Observation of vertebrate use. Definition: Farming practices have an effect on the density and spatial distribution of vertebrates that utilize wetland habitat. Example: If the wetland habitat has been altered to reduce cover and food production vertebrate use will be limited.	Observed vertebrate use. The presence of animal tracks, deer rubs, shed skins, beaver activity, as relate to reference standard.	1.0
	Above indicators much less than the reference standard and habitat appears usable.	0.5
	No observed sign and habitat appears marginal.	0.25
	Wetland assessment area provides no habitat or sign, but adjacent areas provide habitat.	0.1

$V_{OBSVERTUSE}$ Observation of Vertebrate Use
F14 Maintains Characteristic Vertebrate Community

Model Variables	Measurement or Condition	Index
V_{ORGAN}: Organic matter in wetland Definition: Desolved and particulate organic matter(live and dead)	Measured standing stocks of live and dead biomass and soil organic matter. Visual estimates of litter, course woody debris, live woody vegetation, live or dead herbaceous plants, organic rich mineral soils at levels between 75% and 125% that of reference standard.	1.0
Example: Biotic breakdown of detritus material.	As above but between 25% to 75% or >125% of reference standard.	0.5
	As above, but between 1% and 25% of reference standard.	0.1
	No organic matter; no potential for recovery.	0.0

V_{ORGAN} Organic Matter in Wetland
F-7 Exports Organic Carbon and Detritus

Model Variable	Measurement or Condition	Index
V_{PDEN}: Plant Density	Density 75% to 125% of reference standard.	1.0
Definition: Density of woody and/or herbaceous plants.	Density 25% to 75% or >125% of reference standards.	0.5
Example: In combination with other roughness factors (V_{MICRO}, $V_{DETRITUS}$), roughness will result in a slowing of water flow and provide increased time and surface area for processing and export of organic carbon.	Density 0 to 25% of reference standards.	0. 1
	Plants absent.	0.0

V_{PDEN} Plant Density
F-5 Removal of Imported Elements and Compounds
F-7 Exports Organic Carbon and Detritus

Model Variable	Measurement or Condition	Index
V_{PRATIO}: Ratio of Native : Non-Native Plant Species Definition: The ratio of native to non-native plant species within the wetland as indicated by the dominant native plant species or by a more extensive species survey. Example: The presence of a high ratio of native to non-native plant species indicates that disturbances that interrupt naturally occurring cycles and other vegetative dynamics are minimal.	All the dominant species in all zones are native species that are listed as Reference Standard species for zones within the wetland.	1.0
	75% to 100% of the species are native species.	0.75
	50% to 75% dominant species in all zones are native species that are listed as Reference Standard species for the same zone within the Reference Domain and/or 50% to 75% of the species surveyed are native species.	0. 50
	25% to 50% of the dominant species in all zones are native species that are listed as Reference Standard species for the same zone within the Reference Domain and/or 25% to 50% of the species surveyed are native species.	0.25
	Less than 25 % of the most abundant species in all zones are native species that are listed as Reference Standard species for the same zone within the Reference Domain and/or 0% to 25% of the species surveyed are native species.	0.1
	Riparian zone un-vegetated. No native species are present	0.0

V_{PRATIO} Ratio of Native to Non-native Plant Species
F-8 Maintains Characteristic Plant Community
F-11 Maintains Food Webs

Model Variable	Measurement or Condition	Index
V_{REDVEL}: Reduction in flow velocity Definition: Reduction in flow through a wetland during an overbank flooding event. Example: Sediment deposits debris deposited or moved about indicate a wetland's capacity to reduce velocity.	Sediment deposits, silt deposits on vegetation, buried root collars, stacked wracks of debris, etc. similar to reference standard.	1.0
	Sediment scour, scoured root collars, large woody debris moved about; erosion of soil surface, etc., indicating less than reference standard.	0.5
	Directionally bent vegetation, bare soil exposed (not sediment deposits), strongly departing from reference standard.	0.1
	Strong evidence of severe site degradation by channel scour, exposed root masses, suggesting variable is absent.	0.0

V_{REDVEL} Reduction in Flow Velocity
F-3 Energy Dissipation

Model Variable	Measurement or Condition	Index
V_{SED}: Sediment Delivery to Wetland. Definition: Extent of sediment accumulation within the wetland from culturally accelerated sources. Example: Accelerated deposition can be a vector for P and other nutrients and contaminants.	No evidence of recent sediment delivery to the wetland.	1.0
	Sediment delivery to the wetland is evidenced by sediment staining of detritus and/or slight accumulations of sediment along plant stems in the riparian zone.	0.5
	Sediment delivery as evidenced by buried detritus and/or vegetation on wetland edge. Recent deltas, sediment plumes, etc. in areas of concentrated flow.	0.1
	Bottom elevation of wetland raised due to sedimentation, and/or infilling due to tillage.	0.0

V_{SED} Sediment Delivery to Wetland

F-4 Elemental Cycling
F-5 Removal of Imported Elements and Compounds
F-6 Retention of Particulates
F-8 Maintains Characteristic Plant Community
F-10 Maintains Habitat Structure
F-11 Maintains Food Webs

Model Variable	Measure and Condition	Index
V_{SINVT}: Soil invertebrates Definition: Distribution and abundance of invertebrates in soil	Tunnels, shells, casts, holes, etc. in soil similar to reference standard (indirect measures may be developed that can be are quantified).	1.0
Example: Evidence of crayfish mounds and/or worm cast.	As above, but much less than reference standard.	0.5
	No evidence of items above, but with potential for habitat recovery.	0.1
	No evidence of items above but no potential for recovery of habitat.	0.0

V_{SINVT} Soil Invertebrates
F13 Maintains Characteristic Invertebrate Community

Model Variable	Measurement or Condition	Index
V_{SNAGS}: Density of standing dead trees Definition: The presence of dead standing woody debris. (≥ 10 cm DBH and ≥ 2 m tall) Example: The density of standing dead trees relates to the suitability of a site as habitat for invertebrates and vertebrates.	Woody debris 75% to 125% of reference standard. Woody debris 25% to 75% or > 125% of reference standard. Woody debris 0 to 25% of reference standard. Woody debris absent	1.0 0.5 0.1 0.0

V_{SNAGS} Density of Standing Dead Trees
F-9 Maintains Characteristic Detrital Biomass

Model Variable	Measurement or Condition	Index
V_{SORPT}: Sorptive properties of soil Definition: The capacity of a soil to adsorb dissolved elements and compounds. Example: Clays and silts, with high organic carbon content, have greater sorption capacities than coarse texture soils and increased surface area for increased microbial activity. Measured in the upper 20" (50 cm).	Physical properties of soils similar to the reference standard (texture, organic carbon content, color, structure). Soil departs in texture, organic carbon content and other properties. Major departures(e.g., sand to cobbles, clay to sand) Surface lacking soil or natural substrate properties. (e.g., asphalt, road, building)	1.0 0.5 0.1 0.0

V_{SORPT} Sorptive Properties of Soil
F-5 Removal of Imported Elements and Compounds

Model Variable	Measurement or Condition	Index
V_{SPROD}: Soil Productivity Definition: Soil texture influences the diversity of species found at a site. Example: Medium textured soils have the potential for the greatest diversity of species. Reference: Soil Survey Manual pp 136 - 140.	Loamy - medium textured. (VFSL,FSL,L,SL,SIL,SI)	1.0
	Fine loamy - moderately fine texture (CL,SCL,SICL <34% clay)	0.75
	Sandy - Coarse textured. (S, LS, COS, LFS)	0.5
	Fine and Sodic affected soils (SC, SIC, C, SICL > 34% clay)	0.25

V_{SPROD} Soil Productivity
F13 Maintains Characteristic Invertebrate Community

Model Variable	Measurement or Condition	Index
V_{STRATA}: Strata Present Definition: The number of vegetation strata present in the plant community. Example: This will be adjusted based on the type of wetland the model is trying to measure. Single strata wetlands will receive a severe penalty if strata is gone.	All appropriate strata are present.	1.0
	One stratum is absent from the plant community.	0.75
	Two strata are absent from the plant community.	0.5
	Three strata are absent from the plant community.	0.25
	Vegetation is sparse.	0.1
	Vegetation Is absent.	0.0

V_{STRATA} Strata Present
F-8 Maintains Characteristic Plant Community
F-10 Maintains Habitat Structure

Model Variable	Measure or Condition	Index
V_{SURFIN}: Surface inflow into wetland Definition: Overland flow from non-wetland to a wetland.	Any of the following indicators similar to reference standard: 1. Sheet or rill erosion on adjacent non-wetland areas. 2. Lateral tributaries entering floodplain and not connected to the channel. 3. Rearranged litter and/or scour scars leading into a wetland from non-flooded areas.	1.0
	Above indicators less than the reference standards.	0.5
	Absence of the above indicators, Hydraulic gradient manipulated but restoration is possible.	0.1
Example: Surface rills or rearranged litter leading to a wetland from adjacent non - flooded sites.	Absence of the above indicators and hydraulic gradient reversed by channelization across wetland and diversion terraces or ditches at toe of slope. Restoration is not possible.	0.0

V_{SURFIN} Surface Inflow
F-5 Removal of Imported Elements and Compounds

Model Variable	Measurement or Condition	Index
V_{SURWAT}: Presence of surface water Definition: Presence or indication that the surface is inundated for at least 1 week. Example: Overbank flow or ponding for 7 consecutive days or presence of surface water in macro/ micro lows.	*1. Overbank flow sufficient or pond water for 7 consecutive days **or** 2. Direct observation of ponded water **or** 3. Aerial photo evidence confirms flooding similar to reference standard. Compared to regional reference standard: 1. Annual understory (grass and woody reproduction, etc. absent) **or** 2. High organic matter accumulation at soil surface **or** 3. Massive soil structure with low permeability and general lack of small roots in the surface soil horizon **or** 4. Seasonal high water table to 0.0-0.5m of surface	1.0
	As above, but below reference standard.	0.5
	Above indicators absent but related indicators suggest variable may be present.	0.1
	No overbank flow; ponding minor or not evident; no evidence of flooding on aerial photos. Indicators absent and/or there is evidence of alteration affecting variable.	0.0

* Use USGS gage data, if available, as a hydrology tool.

V_{SURWAT} Presence of Surface Water
F-2 Long Term Surface Water Storage
F-13 Maintains Characteristic Invertebrate Community

Model Variable	Measurement or Condition	Index
V_{WETUSE}: Wetland Land Use **Definition:** Dominant land use and condition of the wetland. Example: Disturbance of the wetland impairs the ability of biotic processes to uptake and release elements.	Wetland not tilled in last 5 years. No grazing, haying, or logging occurring. Riparian zone intact.	1.0
	Wetland rarely (<= 2/10) cropped, minimal impact from grazing, haying. and/or logging.	0.75
	No tillage in zones wetter than riparian zone. Riparian zone minimally impacted by light to moderate grazing, haying, logging, no channel or drainage manipulation.	0.5
	Riparian zone tilled, heavily grazed most years or extensively logged, or channel manipulation.	0.25
	Wetland receives conventional tillage in all zones in most years; if recently tilled, evidence of vegetation, clods in furrows, severe channel or drainage manipulation, but restorable, etc.	0.1
	Wetland more severely disturbed than indicated above; severe manipulation and not restorable. (e.g. no vegetation, rutted, feed lot, fill, etc.)	0.0

V_{WETUSE} Wetland Land Use

F-1 Dynamic Surface Water Storage
F-4 Elemental Cycling
F-5 Removal of Imported Elements and Compounds
F-6 Retention of Particulates
F-7 Exports Organic Carbon and Detritus
F-8 Maintains Characteristic Plant Community
F-9 Maintains Characteristic Detrital Biomass
F-10 Maintains Habitat Structure
F-11 Maintains Food Webs
F-12 Maintains Habitat Interspersion and Connectivity

Model Variable	Measure or Condition	Index
V_{WROUGH} : Woody vegetation roughness Definition: Corresponds to the number of woody stems(trees and shrubs). Example: Roughness of stem density detain water, trap organic debris, and slow water movement.	Stem density and/or basal area between 80% and 120% that of reference standard. Visual estimate of trees and shrubs indicates site is similar (between 80% and 120%) to reference standard.	1.0
	Stem density and/or basal area between 10% and 80% that of reference standard. Visual estimate of trees and shrubs indicates site is less (10 to 80%) than reference standard.	0.5
	Stem density and/or basal area <10% that of reference standard. Trees and shrubs sparse or absent relative to reference standard; restoration possible.	0.1
	Woody vegetation absent; restoration not possible.	0.0

V_{WROUGH} Woody Vegetation Roughness
F-1 Dynamic Surface Water Storage
F-3 Energy Dissipation
F-6 Retention of Particulates

Model Variable	Measurement or Condition	Index
V_{wtd}: Depth of Water Table	Seasonal high water table to 0.0 - 0.5 m of surface, and dominant mottling of soils within 0.0 - 0.5 m (e.g._____ series)	1.0
Definition: The available water storage correlates to the drawdown of the water table.	Seasonal high water table to 0.0 - 0.5 m of surface, and dominant low chroma colors (e.g._____ series)	0.5
Example: Estimate by using the median seasonal high waer table as listed in the Soil Survey or by measuring the depth to redoximorphic features.	Soils stay nearly saturated for very long durations and are gleyed near the surace. (e.g._____ series)	0.1

V_{wtd} Depth of Water Table
F-2 Long Term Surface Water Storage

APPENDIX A
RED-YELLOW FLAG FEATURES

R = Hazardous waste sites identified under CERCLA or RCRA

R = Federally Threatened or Endangered Species

Y = Federal Register sites or structure/artifacts of historic or archeological significance

Y = Areas covered under the Farmland Protection Act

Y = Areas providing Critical Habitat for Species in need of Conservation

Y = Critical Habitat for State Listed Threatened or Endangered Species
(see FOTG for KDWP supplement)

Y = Areas protected under the Land and Water Conservation Fund Act

Y = National Wildlife Refuges (adjacent or on)

Y = Areas protected under American Indian Religious Freedom Act and Native Lands:
Kickapoo, Potawatomie, Sac-Fox, Iowa

Y = Areas identified as significant under the Ramsar Treaty

Y = Areas designated as Sole Source Groundwater Aquifers

Y = IGUCA (Intensive Groundwater Use Control Area)

Y = State List of Historic Places

Y = Outstanding Natural Resource Waters in Kansas

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APPENDIX B
Producer Checklist

1. A mitigation site will require a permanent easement for USDA and a deed restriction to prevent the future loss of the site. Are you willing to accept these terms? If you answer no, then establishing a mitigation site is not possible and you should seek other alternatives for your proposed project.

Yes _____ No _____

2. Do you have a suitable mitigation site located? (Mitigation site should be in same local watershed with similar soils, landscape position, and topography.)

Yes _____ No _____

3. Do you own the mitigation site? Yes _____ No _____
If No, can you obtain easement rights? Yes _____ No _____

4. Who will develop the mitigation plan?

____ Owner/operator
____ Employ a consultant to develop the mitigation plan
____ Request assistance from the Natural Resources Conservation Service, Kansas Department of Wildlife and Parks, or U.S. Fish and Wildlife Service to develop mitigation plan

5. Are you willing to obtain any/or all of federal, state, or local permits that apply to this project?

Yes _____ No _____

6. If there are any existing liens on the mitigation site, please ensure that those parties have been notified of the potential mitigation site.

Yes _____ No _____

7. All costs associated with the construction and maintenance of a mitigation site are the responsibility of the individual or individuals proposing the establishment of such site.

APPENDIX C
FUNCTIONAL ASSESSMENT INDEX

HYDROLOGY

1.0 DYNAMIC SURFACE WATER STORAGE

Index of function

Index = $[(V_{FREQ} + V_{WETUSE})/2 \times (V_{INUND} + V_{MACRO} + V_{WROUGH} + T_{HROUGH} + V_{CWD})/5]^{1/2}$

2.0 LONG TERM SURFACE WATER STORAGE

Index of function

For low energy systems: **Index = $(V_{SURWAT} + V_{MACRO} + V_{MICRO})/3$**

For low energy systems with water tables: **Index = $(V_{SURWAT} + V_{WTD} + V_{MACRO} + V_{MICRO})/4$**

3.0 ENERGY DISSIPATION

Index of function

Index = $[V_{REDVEL} + V_{FREQ} + (V_{MACRO} + V_{MICRO} + V_{WROUGH} + V_{CWD})/4]/3$

BIOGEOCHEMISTRY

4.0 ELEMENTAL CYCLING

Index of function

Index = $[V_{CANOPY} + V_{WETUSE} + V_{BUFF} + V_{DETRITUS} + V_{SED}]/5$

5.0 REMOVAL OF IMPORTED ELEMENTS AND COMPOUNDS

Index of function

Index = $[V_{WETUSE} + V_{BUFF} + V_{SED} + V_{SORPT} + (V_{FREQ} + V_{SURFIN})/2 + (V_{MACRO} + V_{MICRO} + V_{DETRITUS} + V_{PDEN})/4]/6$

6.0 RETENTION OF PARTICULATES

Index of function

$$\text{Index} = [(V_{WETUSE} + V_{FREQ} + V_{BUFF} + V_{SED})/4 \text{ X } (V_{WROUGH} + V_{HROUGH} + V_{MICRO} + V_{DETRITUS})/4]^{1/2}$$

7.0 EXPORT ORGANIC CARBON AND DETRITUS

Index of function

$$\text{Index} = [(V_{FREQ} + V_{BUFF} + V_{HYDCON} + V_{WETUSE} + V_{MICRO})/5 \text{ x } (V_{PDEN} + V_{ORGAN} + V_{DETRITUS})/3]^{1/2}$$

If $V_{PDEN} + V_{ORGAN} + V_{DETRITUS} = 0$, then the function is absent.

PLANT COMMUNITY MAINTENANCE

8.0 MAINTAINS CHARACTERISTIC PLANT COMMUNITY

Index of function

$$\text{Index} = (V_{WETUSE} + V_{SED} + V_{DENBA} + V_{CANOPY} + V_{STRATA} + V_{PRATIO})/6$$

9.0 MAINTAINS CHARACTERISTIC DETRITAL BIOMASS

Index of function

$$\text{Index} = (V_{WETUSE} + V_{SNAGS} + V_{DETRITUS} + V_{DECOMP})/4$$

FAUNAL COMMUNITY/HABITAT MAINTENACE

10.0 MAINTAINS HABITAT STRUCTURE WITHIN WETLAND

Index of function

$$\text{Index} = [(V_{WETUSE} + V_{SED})/2 + (V_{CANOPY} + V_{STRATA})/2 + V_{BUFF} + V_{DETRITUS}]/4$$

11.0 MAINTAINS FOOD WEB

Index of function

$$\text{Index} = (V_{WETUSE} + V_{SED} + V_{BUFF} + V_{LANDSP} + V_{PRATIO} + V_{DETRITUS})/6$$

12.0 MAINTAINS HABITAT INTERSPERSION AND CONNECTIVITY

Index of function

$$\text{Index} = [(V_{FREQ} + V_{DURAT})/2 + (V_{LANDSP} + V_{WETUSE})/2 + V_{MICRO} + V_{CONTIG}]/4$$

13.0 MAINTAINS CHARACTERISTIC INVERTEBRATE COMMUNITY

Index of function

$$\text{Index} = (V_{SINVT} + V_{LINVT} + V_{SPROD} + V_{SURWAT} + V_{AQINVT})/5$$

14.0 MAINTAINS CHARACTERISTIC VERTEBRATE COMMUNITY

Index of function

$$\text{Index} = (F8 + F9 + F10 + F11 + F13 + V_{OBSVERTUSE})/6$$

7/97

Appendix D
FUNCTIONAL ASSESSMENT WORKSHEET

1.0 DYNAMIC SURFACE WATER STORAGE

1.0 Index of function

Index = $[(V_{FREQ} + V_{WETUSE})/2 \times (V_{INUND} + V_{MACRO} + V_{WROUGH} + V_{HROUGH} + V_{CWD})/5]^{1/2}$

[(_____ + _____)/2 x (_____ + _____ + _____ + _____ +_____)/5] 1/2

= _____

2.0 LONG TERM SURFACE WATER STORAGE

2.0 Index of function

For low energy systems: **Index = $(V_{SURWAT} + V_{MACRO} + V_{MICRO})/3$**

(_____ + _____ + _____)/3 = _____

For low energy systems with water tables: **Index = $(V_{SURWAT} + V_{WTD} + V_{MACRO} + V_{MICRO})/4$**

(_____ + _____+ _____+ _____)/4 = _____

3.0 ENERGY DISSIPATION

3.0 Index of function

Index = $[V_{REDVEL} + V_{FREQ} + (V_{MACRO} + V_{MICRO} + V_{WROUGH} + V_{CWD})/4]/3$

[_____ + _____ +(_____ + _____ + _____ + _____)/4]/3 = _____

4.0 ELEMENTAL CYCLING

4.0 Index of function

Index = (V_{CANOPY} +V_{WETUSE} + V_{BUFF+} $V_{DETRITUS}$ + V_{SED})/5

(_____ + _____ + _____ + _____ + _____]/5

= _____

5.0 REMOVAL OF IMPORTED ELEMENTS AND COMPOUNDS

5.0 Index of function

Index = [V_{WETUSE} + V_{BUFF} + V_{SED} + V_{SORPT} + (V_{FREQ} + V_{SURFIN})/2 + (V_{MACRO} +V_{MICRO} + $V_{DETRITUS}$ + V_{PDEN})/4]/6

[_____ + _____ + _____ + _____ + (_____ + _____)/2 + (_____ +

_____ + _____ + _____)/4]/ 6 = _____

6.0 RETENTION OF PARTICULATES

6.0 Index of function

Index = [(V_{WETUSE} + V_{FREQ} + V_{BUFF} + V_{SED})/4 X (V_{WROUGH} + V_{HROUGH} + V_{MICRO} + $V_{DETRITUS}$)/4]$^{1/2}$

[(_____ + _____ + _____ + _____)/4 x (_____ + _____ + _____ +

_____)/4] 1/2 = _____

7.0 EXPORTS ORGANIC CARBON AND DETRITUS

7.0 Index of function

Index = [(V_{FREQ} + V_{BUFF} + V_{HYDCON} + V_{WETUSE} + V_{MICRO})/5 x (V_{PDEN} + V_{ORGAN} + $V_{DETRITUS}$)/3]$^{1/2}$

[(_____ + _____ + _____ + _____ + _____)/5 x (_____ + _____ + _____)/3]1/2

= _____

If V_{PDEN} + V_{ORGAN} + $V_{DETRITUS}$ = 0, then the function is absent.

8.0 MAINTAINS CHARACTERISTIC PLANT COMMUNITY

8.0 Index of function

Index = $(V_{WETUSE} + V_{SED} + V_{DENBA} + V_{CANOPY} + V_{STRATA} + V_{PRATIO})/6$

(_____ + _____ + _____ + _____ + _____ + _____)/ 6 = _____

9.0 MAINTAINS CHARACTERISTIC DETRITAL BIOMASS

9.0 Index of function

Index = $(V_{WETUSE} + V_{SNAGS} + V_{DETRITUS} + V_{DECOMP})/4$

(_____ + _____ + _____ + _____)/4 = _____

10.0 MAINTAINS HABITAT STRUCTURE WITHIN WETLAND

10.0 Index of function

Index = $[(V_{WETUSE} + V_{SED})/2 + (V_{CANOPY} + V_{STRATA})/2 + V_{BUFF} + V_{DETRITUS}]/4$

[(_____ + _____)/2 + (_____ + _____)/2 + _____ + _____]/4 = _____

11.0 MAINTAINS FOOD WEBS

11.0 Index of function

Index = $(V_{WETUSE} + V_{SED} + V_{BUFF} + V_{LANDSP} + V_{PRATIO} + V_{DETRITUS})/6$

(_____ + _____ + _____ + _____ + _____ + _____)/6_____

12.0 MAINTAINS HABITAT INTERSPERSION AND CONNECTIVITY AMONG WETLANDS

12.0 Index of function

Index = $[(V_{FREQ} + V_{DURAT})/2 + (V_{LANDSP} + V_{WETUSE})/2 + V_{MICRO} + V_{CONTIG}]/4$

[(_____ + _____)/2 + (_____ + _____)/2 + _____ + _____]/4 = _____

13.0 MAINTAINS CHARACTERISTIC INVERTEBRATE COMMUNITY

13.0 Index of function

Index = (V_{SINVT} + V_{LINVT} + V_{SPROD} + V_{SURWAT} + V_{AQINVT})/5

(_____ + _____ + _____ + _____ + _____)/5 = _____

14.0 MAINTAINS CHARACTERISTIC VERTEBRATE COMMUNITY

14.0 Index of function

Index = (F8+F9+F10+F11+F13+$V_{OBSVERTUSE}$)/6

(_____ + _____ + _____ + _____ + _____ + _____)/6 = _____

Hydrology = F1 + F2 + F3

Biogeochemical = F4 + F5 + F6 + F7

Vegetation = F8 + F9

Wildlife = F10 + F11 + F12 + F13 + F14

Appendix E

VARIABLES WORKSHEET
KANSAS WOODED RIVERINE WETLANDS MODEL

	WETLAND AREA (impacted)	MITIGATION AREA Before Const., Rest., Manip.	MITIGATION AREA After Cost., Rest., Manip.
V_{AQINVT}	_____	_____	_____
V_{BUFF}	_____	_____	_____
V_{CANOPY}	_____	_____	_____
V_{CONTIG}	_____	_____	_____
V_{CWD}	_____	_____	_____
V_{DECOMP}	_____	_____	_____
V_{DENBA}	_____	_____	_____
$V_{DETRITUS}$	_____	_____	_____
V_{DURAT}	_____	_____	_____
V_{FREQ}	_____	_____	_____
V_{HROUGH}	_____	_____	_____
V_{HYDCON}	_____	_____	_____
V_{INUND}	_____	_____	_____
V_{LANDSP}	_____	_____	_____
V_{LINVT}	_____	_____	_____
V_{MACRO}	_____	_____	_____
V_{MICRO}	_____	_____	_____
$V_{OBSVERTUSE}$	_____	_____	_____
V_{ORGAN}	_____	_____	_____
V_{PDEN}	_____	_____	_____
V_{PRATIO}	_____	_____	_____
V_{REDVEL}	_____	_____	_____
V_{SED}	_____	_____	_____
V_{SINVT}	_____	_____	_____
V_{SNAGS}	_____	_____	_____
V_{SORPT}	_____	_____	_____
V_{SPROD}	_____	_____	_____
V_{STRATA}	_____	_____	_____
V_{SURFIN}	_____	_____	_____
V_{SURWAT}	_____	_____	_____
V_{WETUSE}	_____	_____	_____
V_{WROUGH}	_____	_____	_____
V_{WTD}	_____	_____	_____

Appendix F

LOTUS and EXCEL WORKSHEETS

KANSAS WOODED RIVERINE WETLANDS MODEL

Appendix G
Mitigation Ratios for Time/Function Delays

Appendix H

Variable/Function Association

V_{AQINVT} Aquatic Invertebrates - Distribution and abundance of invertebrates in aquatic habitats.

F14 Maintains Characteristic Invertebrate Community

V_{BUFF} Buffer Zone The drainage in the buffer zone impact plant communities and elemental cycling throughout the wetland.

F-4 Elemental Cycling
F-5 Removal of Imported Elements and Compounds
F-6 Retention of Particulates
F-7 Exports Organic Carbon and Detritus
F-10 Maintains Habitat Structure
F-11 Maintains Food Webs

V_{CANOPY} Canopy Cover (percent) How continuous is the upper layers of the forest canopy?

F-4 Elemental Cycling
F-8 Maintains Characteristic Plant Community
F-10 Maintains Habitat Structure

V_{CONTIG} Contiguous Vegetation Cover - Is the wetland and any adjacent riverine forest part of the large block of forest?

F-12 Maintains Habitat Interspersion and Connectivity

V_{CWD} Coarse Woody Debris - Dead and downed trees and limbs greater than 4 inches in diameter and longer than 3 feet in length.

F-1 Dynamic Surface Water Storage
F-3 Energy Dissipation

V_{DECOMP} Decomposition - The evidence of decomposition of woody and herbaceous debris.
F-9 Maintains Characteristic Detrital Biomass

V_{DENBA} Tree Density and Basal Area - The density and basal area of large diameter trees.

F-8 Maintains Characteristic Plant Community

$V_{DETRITUS}$ Detritus - Soil detritus as represented by coverage of the O- and /or A- soil horizons Measured by the average percent of cover of the “O” horizon.

F-4 Elemental Cycling
F-5 Removal of Imported Elements and Compounds
F-6 Retention of Particulates
F-7 Exports Organic Carbon and Detritus
F-9 Maintains Characteristic Detrital Biomass
F-10 Maintains Habitat Structure
F-11 Maintains Food Webs

V_{DURAT} Duration of Overbank Flow - How long water remains out-of-bank.
F-12 Maintains Habitat Interspersion and Connectivity

V_{FREQ} Frequency of Overbank Flow - The frequency at which the channel overtops its banks or water is delivered to the wetland from upland sources.

F-1 Dynamic Surface Water Storage
F-3 Energy Dissipation
F-5 Removal of Imported Elements and Compounds
F-6 Retention of Particulates
F-7 Exports Organic Carbon and Detritus
F-12 Maintains Habitat Interspersion and Connectivity

V_{HROUGH} Herbaceous Vegetation Roughness - Resistance to flow due to herbaceous debris.

F-1 Dynamic Surface Water Storage
F-6 Retention of Particulates

V_{HYDCON} Surface Hydraulic Connections - between the wetland and with main and side channels.

F-7 Exports Organic Carbon and Detritus

V_{INUND} Average Depth of Inundation - The depth to which the wetland is inundated.

F-1 Dynamic Surface Water Storage

V_{LANDSP} Landscape - The condition of the landscape within a one mile radius of the center of the wetland being assessed. This allows for the potential dispersion of vertebrates to and from wetland and uplands connectivity.

F-11 Maintains Food Webs
F-12 Maintains Habitat Interspersion and Connectivity

V_{LINVT} Litter Invertebrates - Distribution and abundance of invertebrates in leaf litter and coarse woody debris.

F13 Maintains Characteristic Invertebrate Community

V_{MACRO} Macrotopographic Relief - Presence of features with an aerial extent sufficient to be detected by aerial photography.

F-1 Dynamic Surface Water Storage
F-2 Long Term Surface Water Storage
F-3 Energy Dissipation
F-5 Removal of Imported Elements and Compounds

V_{MICRO} Microtopographic Complexity - The small hummocks, and depressions that occur in the soil surface.

F-2 Long Term Surface Water Storage
F-3 Energy Dissipation
F-5 Removal of Imported Elements and Compounds
F-6 Retention of Particulates
F-7 Exports Organic Carbon and Detritus
F-12 Maintains Habitat Interspersion and Connectivity

$V_{OBSVERTUSE}$ Observation of Vertebrate Use - Indicators of vertebrate use such as tracts, nesting sites, or deer rubs.

F14 Maintains Characteristic Vertebrate Community

V_{ORGAN} Organic matter in wetlands - The presence of organic carbon include estimates of living and dead biomass.

F-7 Exports Organic Carbon and Detritus

V_{PDEN} Plant Density - Plant density will detain water flow to increase residence time for uptake and breakdown processes. Also, provide entrapment of soil particles and debris.

F-5 Removal of Imported Elements and Compounds
F-7 Exports Organic Carbon and Detritus

V_{PRATIO} Ratio of Native to Non-native Plant Species - Species composition or plant ratio of native to non-native plants is used as an indicator of current wetland conditions as compared to the reference standard.

F-8 Maintains Characteristic Plant Community
F-11 Maintains Food Webs

V_{REDVEL} Reduction in Flow Velocity - Velocity is reduced by surface roughness and obstructions, and by spreading of water over a larger area.

F3 Energy Dissipation

V_{SED} Sediment Delivery to Wetland - Evidence of retained sediments may be indicated by layers of leaves buried under sediment layers, sediment staining on leaves, and presence of natural levees formed by overbank flow.

F-4 Elemental Cycling
F-5 Removal of Imported Elements and Compounds
F-6 Retention of Particulates
F-8 Maintains Characteristic Plant Community
F-10 Maintains Habitat Structure
F-11 Maintains Food Webs

V_{SINVT} Soil Invertebrates - Species composition and abundance of invertebrates by indirect measurement of the presence and activity of soil invertebrates, and insects.

F13 Maintains Characteristic Invertebrate Community

V_{SNAGS} Density of Standing Dead Trees - The average number of dead tree stems in a representative number of plots.

F-9 Maintains Characteristic Detrital Biomass

V_{SORPT} Sorptive Properties of Soil - The ability of soil particles to remove dissolved elements and compounds from water. Fine texture soils have greater sorption capacities than those with coarse textures.

F-5 Removal of Imported Elements and Compounds

V_{SPROD} Soil Productivity - Soil texture influences the diversity of species found at a site.

F13 Maintains Characteristic Invertebrate Community

V_{STRATA} Strata Present - Are all of the vegetation layers of a mature forest present, namely herbaceous layer, shrub layer/vine layer, and tree layer?

F-8 Maintains Characteristic Plant Community
F-10 Maintains Habitat Structure

V_{SURFIN} Surface Inflow - Precipitation and overland flow in uplands adjacent to riverine wetlands may become a water source.

F-5 Removal of Imported Elements and Compounds

V_{SURWAT} Presence of Surface Water - Indicators of ponding, such as absence of regeneration of annual plants, water stained leaves, and drift lines.

F-2 Long Term Surface Water Storage
F-13 Maintains Characteristic Vertebrate Community

V_{WETUSE} Wetland Land Use - The present use of the wetland that may affect evapotranspiration , soil structure, and soil moisture.

F-1 Dynamic Surface Water Storage
F-4 Elemental Cycling
F-5 Removal of Imported Elements and Compounds
F-6 Retention of Particulates
F-7 Exports Organic Carbon and Detritus
F-8 Maintains Characteristic Plant Community
F-9 Maintains Characteristic Detrital Biomass
F-10 Maintains Habitat Structure
F-11 Maintains Food Webs
F-12 Maintains Habitat Interspersion and Connectivity

V_{WROUGH} Woody Vegetation - Resistance to flow due to woody debris.

F-1 Dynamic Surface Water Storage
F-3 Energy Dissipation
F-6 Retention of Particulates

$V_{WATERTABLE}$ - The depth to “seasonal” high water table.

F-2 Long Term Surface Water Storage